

REMARKS

At the outset, the Applicant wishes to thank Patent Examiner J. Cosimer Jacyna for the many courtesies extended to the undersigned attorney during the Personal Interview on April 13, 2005, at the U.S.P.T.O. The substance of this Personal Interview is set forth in the Examiner Interview Summary, and in this Amendment.

The present invention is directed to a pressure fluid control valve, for example a pneumatic valve or a hydraulic valve, comprising:

- a) a valve body having
 - (1) a distribution channel (12) in form of a bore, having an inside diameter (23) and grooves extend radially outward from distribution channel (12)
 - (2) and at least two further channels (8), the further channels leading to the distribution channel
- b) at least one piston arranged in the distribution channel, the piston (11) having:
 - (1) an intermediate element (26)
 - (2) collars (20) facing away from each other and connected to the intermediate element (26) and
 - (3) at least one sealing element (22)

(c) at least two electrically operated coils (174) for actuating piston by electromagnetic force onto at least one of the collars (20) and move them between at least two switching positions to open and close fluid communication between respective ones of further channels and the distribution channel, each coil arranged in the distribution channel within the grooves and adjacent to the opening (91) of the further channels, whereby an inside diameter (176) of the coils (174) corresponds with the inside diameter (23) of the distribution channel (12).

Thus, the amendments to independent claim 55 are as follows.

The feature a) (1) is found in column 17, line 15 to column 18, line 36 (FIG. 18 and 19) of the detailed description of the parent *U.S. Patent No. 6,676,107*. The feature "grooves for the coils" is described for one of ordinary skill in the art from the description in column 17, lines 37 to 43, that the coils must be arranged in separate grooves in view of the declaration of different diameters. Furthermore, the grooves are clearly shown in FIGS. 18 and 19 exactly.

The features in (c) are also described for example in column 17, lines 45 to 63 of parent *U.S. Patent No. 6,676,107 B2*.

Claim 56 was amended to correct a minor typographical error. Newly added claim 57 recites that feature (c) has "electromagnetic forces which act onto the first collar (20) to move the piston in the first direction and onto the second collar (20) to move the piston in the second direction opposite the first direction".

This feature occurs in column 17, line 15 to column 18, line 36 of the parent *U.S. Patent No. 6,676,107 B2*.

During the Personal Interview, it was agreed that the above-noted revisions to the claims would overcome the formal rejection under 35 U.S.C. 112. Withdrawal of this ground of rejection is respectfully requested.

The Applicant comments upon the prior art rejections of the claims as follows.

According to the present invention, there are at least two coils for actuating a piston solely by electromagnetic forces which act onto a first collar to move the piston in a first

direction and onto a second collar to move the piston in a second direction opposite the first direction. The coils are arranged in a groove within the surface of a distribution channel. The coils are arranged near to the opening of further channels leading to the distribution channel. That means that the coils are arranged in an area between the distribution channel and further channel, where the fluid conditions are turbulent (eddy flow). This permits an excellent dissipation of heat produced by the coils at a high switching frequency.

The coils are small and in combination with the arrangement of them in the grooves, the valve can be manufactured with the minimum possible dimensions. The piston has a sealing element which results in a good tightness during fluid communication between a first further channel, the distribution channel and a second further channel. Thus, fluid leakage is prevented. Losses in fluid pressure in the working fluid can be avoided; and the operation of an automated manufacturing installation can safely be performed.

The coils are cooled by the working fluid; and in view of that, the valve permits extremely high switching frequency without the problem of overheating these coils.

None of the prior art documents disclose or suggest the claimed combination of features of the present invention as will now be discussed.

Determan (U.S. Patent No. 4,310,143 A) discloses an electrically controlled valve (10) comprising a housing (32) which defines a cylindrical inner chamber (34). Mounted within chamber (34) is a valve body (38) which includes a cylindrical central member (46) having a central axial passageway (48) therethrough and a plurality of fluid passageways (50, 52, 54, 56, 58) extending radially outward from and are in fluid communication with central axial passageway (48).

Disposed about and encompassing valve body (38) are a pair of symmetrical magnetic members (60, 62). Valve body (38) and magnetic members (60, 62) form a cylindrical body (72). The cylindrical body (72) has cylindrical chambers (74, 76) defined at opposite ends thereof. Mounted within chambers (74, 76) are first and second electromagnetic coils (78, 79). Each coil includes a spool (82) about which is wound an electrical conductor. Mounted within central axial passageway (48) is a movable valve member (90) that includes armature portions (92, 94) at opposite ends thereof and an intermediate portion (96).

Armature portions (92, 94) are magnetizable and the magnetic bias is induced therein by the electromagnetic coils.

The present invention differs from the prior art due to the fact, that at least two coils for actuating the piston are arranged in the distribution channel within grooves separately from each other and provided on the surface of distribution channel.

Furthermore, the piston of the invention is provided with at least one sealing element and thus assures a good tightness in the respective switching positions.

The *Determan* reference teaches that the first and second electromagnetic coils (78, 79) are arranged in cylindrical chambers (74, 76) and are thusly separate from the distribution channel in the valve body (38). Thus, it is not possible that the coils in *Determan* get into contact with the stream of working fluid when the piston is in its one of two switching positions, where one of the further channels and the distribution channel are communicating together. By using the pressure fluid control valve of the prior art, it is not possible to dissipate heat produced by the coils, when on the one hand the switching time of the pressure fluid control valve should be low and on the other

hand, the sampling frequency of the piston should be as high as it can. *Determan* also has the problem, that the pressurized fluid can pass through the gap between the axial passage (48) and the armature portions (92, 94) of the valve member (90). Thus, leakage cannot be avoided and the pressure in the working fluid stream decreases. Hence, a pneumatic or hydraulic system controlled by the valve of *Determan* cannot be operated safely.

Sanders (U.S. Patent No. 4,679,593 A) discloses a solenoid valve having a valve body (12) and a bore (18) arranged therein, in which a valve spool (44) is slideable disposed. The valve spool has a central longitudinal opening (58) in which a central core (62) and a selectively energizable coil (60) are coaxially positioned. The coil establishes a magnetic field when energized. The valve body (12) has fluid passages (24, 26, 30) formed therein. Fluid communication between the passages is controlled by the linear movement of the valve spool (44) along the coil and core inducted by the magnetic forces.

Thus, the coil is surrounded by the valve spool and does not get into direct contact with the high pressure fluid stream passing the opening of fluid passages (24, 26, 30). If the frequency of changing the switching positions of piston is high, the radiated heat of the coil increases and is stored within the

valve spool. This causes a negative change in the characteristics of the working fluid. Furthermore, the solenoid valve of *Sanders* has a big disadvantage, that the valve spool is guided along the cylindrical coil as well as the valve body (12). This means that a small clearance is needed between the valve spool and both of the coil and the valve body. If one of these components is not manufactured exactly in dimension, it is possible that the valve spool (44) cannot fit within a passage of the valve body (12) and the valve is defective.

Additionally, *Sanders* does not disclose sealing elements on the valve spool and in view of the problem of clearance between valve spool, coil and valve body during the operation of valve, there will be some leakage.

The present invention differs from the disclosure of *Sanders* due to the fact, that there are at least two coils for actuating a piston by electromagnetic force onto at least one of the collars. Each coil is arranged in the distribution channel within a groove and is adjacent to the opening of the further channels, whereby the inside diameter of the coils corresponds with the inside diameter of the distribution channel.

Campagnuolo (U.S. Patent No. 3,686,520 A) discloses a generator for inducing voltage in a coil (14). The generator comprising a metal diaphragm (18), a ring magnet (9) and on its lower edge an iron bottom plate (11) and on its upper edge an iron cover plate (4) which has an air conduit (3). Inside of the ring magnet (9) is a non-magnetic diaphragm support member (10). This member has a series of notches (17) around its upper edge. The plate (11) has a bore (15) and a surrounding coil (14). With the introduction of air into the conduit (3), the pressure build-up above the diaphragm (18) forces the center of the diaphragm down, thus raising the outer peripheral edge thereof. Thus, the air can escape into the lower portion of the generator by the notches (17) down into the lower cavity of the generator whereby the air exits through the bore (15). As soon as the air pressure above diaphragm (18) is relieved, the diaphragm returns to its starting position by the action of the ring magnet on the diaphragm. Pressure build-up reoccurs and cyclic operation commences. The cyclic operation modulates the magnetic field exiting within the diaphragm chamber and induces an electromotive force into coil (14).

The purpose of the structure disclosed by *Campagnuolo* is totally different from the object of the claimed invention. Because the claimed pressure fluid control valve is for the

purpose of controlling a pneumatic or hydraulic system like a pneumatic cylinder in a manufacturing machine, it is not to produce energy. Nevertheless, in the present invention, at least two electrically operated coils are needed for actuating a piston by electromagnetic force onto at least one of its collars and to move them between at least two switching positions to open and close fluid communication between respective ones of further channels and the distribution channel. *Campagnuolo* does not disclose that the coil (14) actuates a metal diaphragm (18) to assuming two positions to open and close fluid communication between the channels.

Levitan (U.S. Patent No. 6,460,557 B1) discloses a pressure fluid control valve comprising a valve body having a distribution channel (housing bore) and at least two further channels, the further channels leading to the distribution channel. A piston is arranged in the distribution channel which can assume two switching positions to open and close communication between respective ones of the further channels (115, 117, 118, 120, 122) and the distribution channel. The piston is made from a magnetic material and comprises a plurality of lands (130, 132, 134) which comprises a sealing surface configured for placement against the inner surface of the housing bore for forming a fluid seal. A coil associated with the exterior surface of the valve body and configured to produce a magnetic field applied to a land so as to

transmissionlessly move the piston in a first direction. In a second direction opposite the first direction, the piston is moved by springs (140). In contrast to the prior art, the invention claims coils which are arranged in the distribution channel within grooves and get into contact with the working fluid; and the piston is only adjusted in both directions by electromagnetic forces which act onto its collars.

Levitan has as a prior art date, its U.S. filing date of October 27, 2000, which is subsequent to the grandparent U.S. patent application filing date of September 22, 2000. Thus, *Levitan* is not available as prior art.

Schmidt (U.S. Patent No. 2,967,545 A) discloses a fluid control valve comprising a valve body (1) having a distribution channel and further channels (3 to 6) leading to the distribution channel. A piston is arranged in the distribution channel which has on its opposite ends magnet plates (11) and magnet cores (12) connected rigidly to the piston (2). The valve further comprises electromagnets arranged outside the distribution channel at opposite ends of the distribution channel (elongated bore) within the valve body (1) and comprising a coil (13) and a cover (15). The piston is actuated by the electromagnets to open and close fluid communication between respective ones of further channels and the distribution channel.

The present invention differs from the prior art due to the fact that the coils are arranged in the distribution channel within grooves and get into contact with the working fluid.

Nagai (U.S. Patent No. 5,967,904 A) discloses a golf club head and is not relevant to the claimed invention.

Mesenich (U.S. Patent No. 4,798,329 A) discloses a valve assembly for metering the rate of flow of a fluid, comprising housing means (24, 26), electrical field coil means (110) carried by the housing means, pole piece means (124), valve seat means (140), fluid flow passage means (154) formed through the valve seat means. The pole piece means comprising a pole piece axial end portion, a valve member situated generally between the pole piece axial end portion and the valve seat means, resilient means normally operatively resiliently urging the valve member in a first direction toward operative seating engagement with the valve seat means to thereby terminate flow of fluid through the fluid flow passage means. The field coil means when energized creates a field flux causing the valve member to be moved in a second direction opposite to the first direction away from the valve seat means as to thereby permit flow of fluid through the fluid flow passage means. Furthermore, the valve comprises a fluid pressure regulator means operatively carried by and connected directly to the housing means. It is arranged to

enable the static as well as the dynamic rate of flow of fluid through the fluid flow passage means.

The purpose of the structure of *Mesenich* is totally different from the claimed invention. Nevertheless, in the present invention, at least two electrically operated coils are needed for actuating a piston by electromagnetic force onto at least one of its collars and move them between at least two switching positions to open and close the fluid communication between channels. *Mesenich* does not disclose that the coil (110) is arranged in a groove within the housing (26), but this coil is mounted on a guide pin arranged in a tubular chamber (70) within the housing (26).


For all these reasons set forth above, none of the prior art references provide an identical disclosure of the claimed invention. Hence, the present invention is not anticipated under 35 U.S.C. 102. Withdrawal of this ground of rejection is respectfully requested.

In summary, claims 55 and 56 have been amended; claim 57 has been added; and claims 55 to 57 are pending. In view of these amendments, it is firmly believed that the present invention and all the claims are patentable under 35 U.S.C. 103 over all the

prior art applied by the Patent Examiner. A prompt Notification of Allowability is respectfully requested, especially since the Examiner Interview Summary indicated allowable subject matter.

Respectfully submitted,
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Encl.: Copy of Petition for Two (2) Month Extension of Time

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